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Influence of feed composition and membrane fouling on forward osmosis performance

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Abstract

Clean water is a basic human need. However, rapid population growth and climate change result in an increase of water demand, whereas the resources of potable water are shrinking. One of the solutions could be to use membrane technology to reclaim clean and safe drinking water from wastewater. Nonetheless, the existing membrane technologies often face fouling problem that lowers the economic viability of the membrane application in industrial scale.
Recent development in the membrane technology indicates that forward osmosis (FO) has a high potential for wastewater treatment, producing high quality water [1]. Compared to other pressure driven membrane processes, forward osmosis (FO) membranes suffered less severe fouling due to the lack of hydraulic pressure [2]. Furthermore, novel biomimetic membranes incorporating Aquaporins, highly selective water channels, became commercially available. These membranes were reported to achieve remarkable results in terms of water flux and solute rejection, though little is known whether they are suitable for wastewater treatment.
The objective of this study is to investigate 1) which types of wastewater can be treated by FO using biomimetic Aquaporin membranes, 2) which draw solution is most suitable for this application and 3) the extent and nature of the fouling.
All experiments were conducted in a bench-scale FO setup using NaCl, $MgCl_2$, NaOAc as a draw solution and different anaerobic digestion effluents as a feed. The effluents were characterised at the beginning and at the end of each experiment, regarding their total solids (TS), volatile solids (VS), total suspended solids (TSS), particle size distribution, Total Kjeldahl Nitrogen (TKN), Total available nitrogen (TAN), total organic carbon (TOC) and total phosphate (TP). The fouled membranes were analysed by Scanning Electron Microscope with Energy-dispersive X-ray spectroscopy (SEM-EDS), Fourier transform infrared spectroscopy (FTIR), ATP analysis and inductively coupled plasma optical emission spectrometry (ICP-OES). Our preliminary experimental results indicate that there is a correlation between the effluent composition and the fouling potential. Taken together our results can contribute understanding of how fouling can be mitigated by considering various feed pretreatment methods.

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